**Unfamiliar with aerial predators** *and with few places to hide, the island fox has suffered a severe population decline since 1994 at Channel Islands National Park (California). Nonnative, feral pigs living on the islands now support a year-round population of golden eagles that also prey on the small and vulnerable canid species.*

*Maintaining the health of ecosystems is a common struggle for park resource managers and represents the primary challenge for the National Park Service in the 21st century. Particularly pervasive problems are water and air pollution as well as exotic plant and animal infestations and their consequences for native species. The advent of the Natural Resource Challenge in 1999 will certainly help address these trouble spots. For example, long-term ecological monitoring will receive a boost from the initiative. A vital resource management tool, monitoring helps reveal accelerated or unhealthy changes in the condition of natural resources, giving resource managers time to intervene. As the first article in this chapter explains, monitoring was responsible for detecting the decline in the island fox population at Channel Islands National Park. Long-term monitoring and the other emphases of the Challenge will help combat the many pressures that negatively impact park natural resources, including those described in the following articles.*

Wildlife

## Island foxes, golden eagles, and feral pigs: When is predation not natural?

*by Tim Coonan*

tim_coonan@nps.gov
Biologist, Channel Islands National Park, California

Island foxes *(Urocyon littoralis)* at Channel Islands National Park have indirectly fallen victim to nonnative feral pigs. The pigs support a breeding population of golden eagles *(Aquila chrysaetos),* which prey on island foxes in addition to piglets. The decline is so severe that only 15 foxes are known to exist on San Miguel Island, and the park is now taking extraordinary emergency action to prevent extinction of the species.

The island fox is one of the world's smallest and most restricted canid species. Six subspecies are distributed on the six largest of the California Channel Islands, one subspecies per island. The park began monitoring the species on San Miguel Island in 1993 as part of its long-term ecological monitoring program. Fox densities initially were high, but the San Miguel population declined from approximately 450 adults in 1994 to less than 20 in 1999. Similar declines occurred simultaneously on neighboring Santa Cruz and Santa Rosa Islands.

Research allowed the park to eliminate disease and parasites as primary mortality factors, but research on Santa Cruz Island had pointed to eagle predation as an important mortality factor for its island foxes. The park began a radiotelemetry study in fall 1998 to determine mortality causes for foxes on San Miguel Island. Within four months, four of eight foxes were killed by golden eagles, and fox survivorship over the yearlong study was approximately 10%. The eagle predation is unnatural; golden eagles were never known on the islands until the 1980s, because a prey base to support them was never present, and native bald eagles probably drove them off. A new prey base (feral pigs on Santa Cruz Island) has allowed golden eagles to roost, winter, and now breed on the northern Channel Islands. Foxes are vulnerable because they have never known aerial predators, and because vegetation changes brought about by historic livestock grazing resulted in the replacement of shrub communities by nonnative annual grasses, which offer virtually no cover from aerial predators.

> "Foxes are vulnerable because they have never known aerial predators."

Concerned about the imminent extirpation of three subspecies of island foxes, the National Park Service convened an island fox recovery team in 1999. The team recommended that (1) golden eagles be removed from the Channel Islands, (2) captive breeding be established on San Miguel and Santa Rosa Islands, (3) bald eagles be reintroduced, and (4) feral pigs be removed. The park started a captive breeding program on San Miguel Island in 1999. As the year ended, 14 foxes had been placed in the facility, and only 1 fox was known to exist in the wild. The park will

**Population monitoring begun in 1993** *revealed the sharp decline in island foxes. To save the species, park managers implemented a captive-breeding program on San Miguel Island in 1999. At year's end, 14 foxes had been placed in the facility and only one was known to exist in the wild.*

establish captive breeding on Santa Rosa in 2000, and is cooperating with the Santa Cruz Predatory Bird Research Group to remove golden eagles from the northern Channel Islands.

The park has begun planning for removal of feral pigs from Santa Cruz Island, but this will be a costly endeavor. Until the pigs are removed, however, they may attract golden eagles that will prey on island foxes. Far from being a single-species management crisis, the interaction of pigs, eagles, and foxes illustrates the pervasive influence that nonnative species can have on ecosystem structure and function, especially in simplified island systems. The decline of the island fox also underscores the importance of ecological monitoring. Without such programs, parks will not be able to detect change in the condition of park resources in time to take corrective action.

## Exotic Vegetation

# Catoctin Mountain Park tackles invasive plants

*by K. L. Kyde*

terra.clara@gateway.net
Primary Field Scientist and Ecologist, Hood College, Frederick, Maryland

Two of the biggest threats to native plant populations are habitat destruction and nonnative species invasion. In Catoctin Mountain Park (Maryland), two shade-tolerant nonnative species, Japanese stilt grass and garlic mustard, are invading some of the park's most botanically diverse sites, forming monocultures, and seemingly crowding out native species. In a research project funded by Canon U.S.A., Inc., the park set out to quantify the extent of nonnative plant invasion, to assess its effect on rare and threatened species, and to compare the effectiveness of three control methods on the worst invaders.

During the 1999 field season a team of Hood College (Maryland) ecologists, park resource managers, summer Youth Conservation Corps members, and student volunteers surveyed 77 plots in the park. These included previously established vegetation-monitoring plots, new roadside plots, and plots set up on a grid throughout the park's undeveloped acreage. They covered all the geologically and floristically distinct habitats in the park and sites ranging from highly

**Ecologists, resource managers, and volunteers** *pull nonnative weeds by hand from a study plot at Catoctin Mountain Park, Maryland. The effort is part of an ongoing experiment to test the efficacy of three methods of controlling nonnative, invasive plant species in the park.*

disturbed to rarely visited. In each plot, in addition to recording data on the existing native species, researchers identified and estimated the percentage of cover of a group of especially problematic woody and herbaceous nonnative species.

"Two of the biggest threats to native plant populations are habitat destruction and nonnative species invasion."

Late in summer 1999 the team set up plots to test methods of controlling Japanese stilt grass and garlic mustard plus two shrubs, multiflora rose and Japanese barberry. All four species present significant threats to park resources. Researchers used torching, spraying with herbicide, and hand pulling to remove the exotics from the test plots. Results will be observed and evaluated during the 2000 field season. Assessment of invasive species threats to rare species will also be completed in 2000.

Project scientists are completing analysis of the data gathered so far. Initial findings indicate that Japanese stilt grass presence is significantly linked to disturbance, even when that disturbance occurred many years ago. Japanese stilt grass and garlic mustard populations are increasing and spreading farther into the park. Because deer in Catoctin Mountain Park do not browse these species, seeming to prefer native species, the team expects to find that browse leads to further increases in nonnatives. The park has already found that deer browse significantly reduces species richness and diversity among herbaceous plants.[1]

Funding for this research came from Expedition Into The Parks, a grant program funded by Canon U.S.A., Inc., in conjunction with the National Park Foundation. The program provides grants for national parks to address crucial resource management issues in partnership with university scientists and community and volunteer organizations. Canon also supplied the park with camera equipment to help document the research.

In addition to the Canon support, the park spent $10,000 in 1999 for labor and supplies to control exotic species, a large amount for a park only 5,770 acres in size. This research will provide resource managers with detailed information about the identity, size, and location of nonnative species invasions; any immediate threats to rare species from invaders; and the relative costs and efficacy of control methods for four major exotic invasive species.

[1] Boucher, D. H., and K. L. Kyde. 1999. Effects of deer exclosures on plant abundance and diversity in Catoctin Mountain Park, Maryland: 1999 results. Report to Catoctin Mountain Park.

Water Pollution

# Water quality concerns related to personal watercraft usage

*by Mark VanMouwerik*

mark_vanmouwerik@nps.gov
Contaminants Specialist, Water Operations Branch, NPS Water Resources Division; Natural Resource Program Center, Fort Collins, Colorado

Two-stroke engines used in personal watercraft (PWC) were linked to water quality concerns during 1999 as a result of a comprehensive literature review on the subject by staff of the Water Resources Division. Research included a review of current literature—journal articles, gray (or less formal) scientific literature, government documents, information from websites—and personal communications with leaders in the industry and in regulatory and scientific research fields. This review was conducted at the request of the NPS Ranger Activities Division in Washington, D.C., to provide information that might aid resource management decisions pertaining to park waters.

Commonly known as "jet skis," PWCs are found in about 34 of the 87 areas of the national park system that allow motorized boating. Most personal watercraft, and most outboard-engine motorboats, use a conventional two-stroke engine that can discharge up to one-third of its fuel directly into the water. Personal watercraft have been found to discharge more unburned fuel into water than do outboard (two-stroke) motorboats because of differences in design and operation. One study comparing these two types of watercraft found that PWCs, though representing only one-third of the watercraft observed, emitted 80% of total watercraft hydrocarbon emissions.

"Surprisingly low concentrations (parts-per-trillion range) [of PAH compounds] can cause adverse effects in both fish and zooplankton through phototoxicity."

The pollutants of greatest concern are methyl tertiary butyl ether, or MTBE (an oxygenate added to gasoline), and polycyclic aromatic hydrocarbons, or PAHs (by-products of the combustion process). Concentrations of MTBE in lakes and reservoirs with heavy PWC use have been observed to exceed federal health advisory levels, State of California human health standards, and thresholds for taste and odor. In drinking-water reservoirs, MTBE is particularly worrisome since experts are uncertain whether it can be easily removed by water treatment plants with conventional water treatment methods. Aquatic life does not appear to be threatened by observed concentrations of MTBE, but more research is needed to confirm this conclusion.



**Personal watercraft,** *such as these at Glen Canyon National Recreation Area (Utah and Arizona), commonly use two-stroke engines that discharge pollutants from burned and unburned fuel into park waters. In 1999 the National Park Service conducted a literature review that linked two-stroke engines to water quality concerns.*

Concentrations of PAHs in lakes and reservoirs with high motorboat activity have been found at levels dangerous to aquatic organisms. Surprisingly low concentrations (parts-per-trillion range) can cause adverse effects in both fish and zooplankton through phototoxicity—that is, greatly increased toxicity of PAHs in the presence of sunlight. Also, at observed concentrations, PAHs may pose a risk to human health in lakes and reservoirs that serve as drinking-water supplies or from which fish are caught and eaten.

Direct-injection, two-stroke engines are now becoming available for PWCs. Because this new technology allows more complete combustion, the discharge of unburned fuel—including MTBE, if used—would be greatly reduced. However, since PAHs are not present in unburned fuel but rather are by-products of combustion, it is uncertain how this technology would affect PAH inputs into the water.

In March 2000 the National Park Service published in the *Federal Register* a final rule that prohibits PWC use in most units of the national park system. The rule allows PWC use to continue in 10 national recreation areas. Eleven additional areas will have a two-year grace period from the general prohibition so that NPS staff can review PWC use and develop special regulations if continued PWC use is deemed appropriate. A park's enabling legislation, park general management plan, other uses, and resource impacts are all considered in determining the appropriateness of continued PWC use. Studies of PAH and MTBE contaminants in these areas are expected to increase given this new rule. Off-road vehicle use in parks is also being reviewed—and in the case of snowmobiles, severely restricted—to make certain that park resources remain unimpaired. The PWC regulation is available on the Internet by selecting "Personal Watercraft Use …" from the NPS Web page www.nps.gov/refdesk/hotdocs.htm.

## Award-Winner Profile

### Rick Potts given Trish Patterson–SCA Award

Richard R. Potts II is the Natural Resource Program manager at Kalaupapa National Historical Park, Hawaii, and recipient of the Trish Patterson–Student Conservation Association Award for Natural Resource Management in a Small Park. In just over three years, Rick transformed natural resource management at the park from virtual nonexistence into an energetic program that addresses a wide range of issues from an ecosystem perspective. He identified threats in designated high-priority "special ecological areas" within the park and obtained funding to equip a vegetation management specialist. Under Rick's leadership, several thousand acres are being protected from alien ungulates by fencing, administrative hunting by local hunters, and aerial shooting. Also, he instituted monitoring programs for key native species, developed population estimates of axis deer and pigs, and helped protect marine and freshwater resources in Kalaupapa. As a result of the award, the Student Conservation Association will underwrite a seasonal resource assistant position for the park.

**Rick Potts discusses** *Kalaupapa's coral reef and ocean resources with Molokai High School students.*

Rick is quick to point out the importance of involving local students in the protection of the park's natural resources. "With the constant bombardment of new threats to Molokai's ecosystem," he says, "I believe the only chance we have to preserve what's left lies in their willingness to … take an active interest. Theirs may very well be the last generation that still has the option of saving this ecosystem." He continues, "Anyone with a trained eye who has been here awhile can certainly see the fabric of ecosystem stability unraveling. [These students] are our last hope, and it is deeply fulfilling and encouraging for me to have the opportunity to interact with them."

Rick is proud to have won the award, but prefers to remember its namesake, Trish Patterson, an NPS resource manager with the Southeast Region who was known for her efforts to assist small parks in her region. She was killed in a car accident in 1995. "Incredibly vibrant and so full of life, she continues to assist field staff through this award," Rick says of Patterson. "[The award] hangs on my wall not as recognition for past accomplishments, but rather as a challenge to try to live up to all it stands for."

Water Quality Monitoring

# Cooperative monitoring program examines nutrient management issues at Saint Croix National Scenic Riverway

*by Randy Ferrin*

randy_ferrin@nps.gov
Chief, Resource Management, Saint Croix National Scenic Riverway, Wisconsin

Agencies responsible for the management and protection of the Saint Croix National Scenic Riverway (NSR—Minnesota and Wisconsin) and its watershed took steps in 1999 to address threats to water quality from increased nutrient loading, primarily phosphorus. The interagency Saint Croix Basin Water Resources Planning Team (Basin Team) developed and implemented a multiagency water quality–monitoring program. The program's objectives were to validate the concern over nutrients and to provide the data needed for modeling the impacts of phosphorus and setting phosphorus standards. The effort built upon the preliminary results of the USGS National Water Quality Assessment (NAWQA) Program, NPS Water Resources Division–funded studies, and the riverway's Water Resources Management Plan.

The Saint Croix NSR is one of the original components of the national wild and scenic rivers system. In addition to its scenic qualities, the river was designated for its outstanding biological diversity, related largely to its good water quality. With an expanding population in the Twin Cities metropolitan area and corresponding land use conversions, water quality in the Saint Croix River is under constant threat from the hundreds of tributaries

Saint Croix National Scenic Riverway, Marianna Young

**Outstanding scenery,** *biological diversity, and good water quality played a role in the designation of Saint Croix National Scenic Riverway as an initial component of the national wild and scenic rivers system in 1968. In 1999 the National Park Service and several partners implemented a water quality–monitoring program to protect the riverway and its watershed from the threat of increased nutrient loading, particularly phosphorus.*

Saint Croix National Scenic Riverway, Marianna Young

**The monitoring program** *entails semimonthly water sampling at 27 sites on the river and its tributaries. Twenty specific parameters are measured, using both field and lab techniques, to provide data for modeling the impacts of phosphorus and setting phosphorus standards.*

draining its 7,650-square-mile (19,814-square-kilometer) watershed. Realizing this threat, the riverway staff and cooperators formed the Basin Team in 1994, involving more than 10 agencies and organizations. The Basin Team identified nutrient enrichment as one of the primary threats to water quality and set a goal in 1998 of no net increase in phosphorus loading to surface water within the basin.

> "The concern ... is ... algal blooms that would cause eutrophic conditions, lowering dissolved oxygen levels."

Phosphorus is an essential element for most life-forms, but in excess concentrations in lakes or rivers it can create significant problems. The concern for the Saint Croix River is the potential for algal blooms that would cause eutrophic conditions, lowering dissolved oxygen levels and triggering numerous related problems, such as changes in the structure of aquatic communities. Though other nutrients, such as nitrogen, are necessary for algal blooms, phosphorus is the limiting nutrient in the Saint Croix.

The 35-page monitoring plan took over a year to develop and implement. Hurdles included synchronizing fiscal year budgets that differed among participating agencies; selecting sampling sites, parameters, and methods; and ensuring quality control. Sampling was done at 27 sites on the riverway and representative tributaries every two weeks from May to October 1999. Riverway staff were responsible for three sites. More than 20 specific parameters were measured using both field and lab techniques. Three separate labs were used by the 10 agencies conducting the monitoring. A quality assurance program ensured the integrity of the data. In addition to surface water sampling, all major dischargers in the river basin monitored the nitrogen and phosphorus levels in their effluent. Six sites monitored by volunteers were also established to inform and involve the public and to gauge the public's perception of water quality conditions.

The data will be collated for analyses and modeling in spring 2000. The Basin Team will develop a nutrient management plan based on the results of the modeling. This may include recommendations for policy changes, best management practices, or new water quality standards.

***West Nile virus***

*West Nile virus (WNV) was found in the Western Hemisphere for the first time in 1999. This mosquito-transmitted virus caused about 60 human disease cases in New York City during the year, resulting in seven deaths. The virus has also caused mortality in several wild bird species (crows appear to be especially vulnerable) and in horses. Gateway National Recreation Area, Fire Island National Seashore, and Sagamore Hill National Historic Site are within the area where viral activity was demonstrated. With the assistance of Howard Ginsberg of the USGS Patuxent Wildlife Research Center, these parks and others in the Northeast are developing surveillance and management protocols to monitor mosquito populations and viral activity in the next active season and to respond appropriately in the event of disease risk.*

***San Francisco–area park units compensated for oil spill damage***

*More than $3.4 million was deposited in the Department of the Interior's Natural Resource Damage Assessment and Restoration Fund in late 1998 on behalf of the National Park Service and other natural resource trustees. The settlement payment is the result of the* S.S. Cape Mohican *oil spill in San Francisco Bay in October 1996. Four units of the national park system were affected by the spill: Fort Point National Historic Site, San Francisco Maritime National Historical Park, Point Reyes National Seashore, and parts of Golden Gate National Recreation Area. The spill damaged natural resources at several of the sites and deprived the public of use of the sites, allowing the National Park Service, through its Environmental Quality Division, to seek damages under the authority of several laws, including 16 U.S.C. §19jj et seq., commonly called the Park System Resource Protection Act. The settlement is being used to fund related natural resource restoration projects at the various park units. These include rehabilitating wetlands, sandy beaches, and rocky intertidal and dune habitats, and enhancing public areas and services that were affected by the spill.*

# Water quality study addresses pollution questions at Chattahoochee River National Recreation Area

*by Adrienne Funk*

adrienne_funk@nps.gov
Conservation Assistant, Student Conservation Association;
Chattahoochee River National Recreation Area, Georgia

Visitors to Chattahoochee River National Recreation Area (NRA) often ask, "Is the water polluted?" Responding to this question is a problem confronting the staff of this 16-unit park located on the Chattahoochee River, which runs through metropolitan Atlanta. Although the park provides vital green space and river recreation for 3.5 million annual visitors, unprecedented recent growth in Atlanta has resulted in pervasive contamination of the river and its tributaries. Giving a precise answer to the pollution question is difficult because water quality in the river changes on a daily basis. Even when information is available, the National Park Service has not been able to distribute it in a timely way to park visitors.

Answers are beginning to emerge, however. In FY 1999, Chattahoochee River NRA and the U.S. Geologic Survey (USGS) began a two-year, microbial water quality–monitoring project to identify the severity and extent of microbial contamination in the river and eight tributaries within the national recreation area. Fecal coliform, *E. coli,* and enterococci, indicators of bacterial pathogens in the water, are particular problems at Chattahoochee. They come from animal waste, leaking and overburdened sewers, wastewater treatment facilities, leachate from septic tanks, and fecal matter associated with storm-water runoff. Although their presence does not prove the presence of pathogenic bacteria, monitoring them is less expensive and easier than monitoring pathogenic bacteria and is useful for judging the relative safety of the recreational use of a water body.

**Animal waste and overburdened sewers** *are two sources of water pollution affecting the Chattahoochee River National Recreation Area in metropolitan Atlanta. In 1999 the National Park Service and the U.S. Geological Survey began a water quality–monitoring project to identify the severity and extent of microbial contamination in the river and eight tributaries in the national recreation area.*

This project used new methods to address water quality issues that are problems for parks nationally. Samples were analyzed for microbial indicators such as coliphages and *Clostridium perfringens,* and organic "wastewater tracers" such as caffeine, detergent metabolites, plasticizers, and fire retardants. These indicators and tracers had never before been measured in the Chattahoochee River. The goal is to relate them to land use, point and nonpoint sources, and hydrologic conditions such as river-flow levels and turbidity.

"Samples were analyzed for ... organic 'wastewater tracers' such as caffeine, detergent metabolites, plasticizers, and fire retardants."

The Chattahoochee National Recreation Area and the USGS are also funded to track the sources of microbial contamination. Ribosomal RNA typing or "ribotyping" of *E. coli* is being used to determine the relative importance of various hosts (for example, humans, dogs, and Canada geese) in contributing microbial contamination to the watershed. Ribotyping is a genetic analytical technique analogous to criminal forensics. Ribotypes of *E. coli* from water samples are compared to ribotypes of *E. coli* isolated from different hosts. The percentage of matches among water samples and source fecal samples provide information on the extent and distribution of each host's contribution to fecal contamination of water resources among various tributaries within the study area.

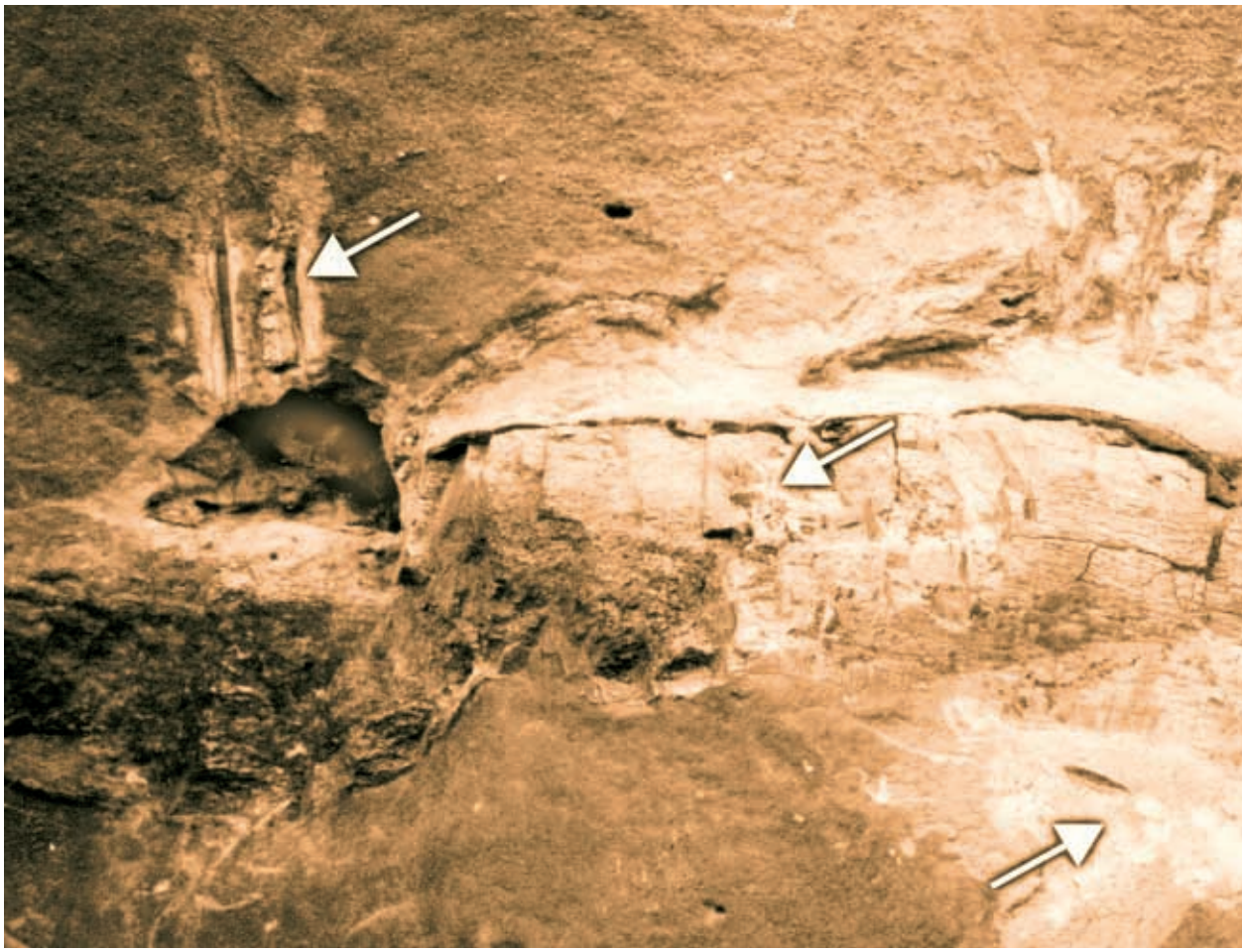
Although it is ongoing, the water quality study has already made a significant contribution to answering the question about pollution in the Chattahoochee River. Microbial contamination is chronic with widespread exceedances of both Georgia and U.S. standards for drinking water, recreation, and fishing. During summer recreation seasons, standards are exceeded in most tributary streams during wet weather. Some highly urbanized streams exhibit their highest fecal coliform concentrations during base flow conditions, indicating point sources for the contaminants. Preliminary *C. perfringens* and organic sewage tracer data indicate widespread contamination of tributary and Chattahoochee River water from both point and nonpoint sources of sewage and fecal material. The project website (http://ga.water.usgs.gov/projects/chatm) provides useful scientific information to both national recreation area staff and the public on the safety of park waters with regard to microbial pollution and includes project publications. During the one year of data collection, the website was updated every five days during the summer recreation season (May-October) and every eight days during the winter months.

Future study findings may help staff restore better water quality in the national recreation area by providing compelling scientific data in the debate over extent, timing, and sources of microbial contamination. Additionally, results from the study may help the National Park Service design and establish a needed, long-term water quality–monitoring program after the two-year study is complete.

## Documented cases of illegal fossil collecting increase at Badlands

The high-profile fossil theft investigation in the early 1990s involving the *Tyrannosaurus rex* specimen named Sue had direct links to illegal fossil-collecting activities at Badlands National Park. The nearly complete fossil skeleton was discovered on the Cheyenne River Indian Reservation in South Dakota in 1990. A court awarded fossil ownership to a Cheyenne River Sioux, who sold the prize specimen in 1997 for $8.4 million to the Field Museum of Natural History of Chicago, where it went on display in spring 2000.

Intensive illegal collecting of fossils from Badlands National Park had been occurring for at least a decade before the "Sue" case. Beginning with the seizure of the famous dinosaur specimen in 1992, there was a significant drop in the number of documented incidents of fossil loss in the park (park records indicate only two incidents from 1995 to 1997). The reduction in reported incidents is supported by researchers' claims of fewer encounters with fossil poachers and little evidence of poaching in the park during that period. In spring 1999 the park reported 20 paleontological resource incidents after paleontological resource protection training was provided to staff (see story on page 42), indicating that awareness training is a key factor in recognizing and preventing illegal fossil collecting.



**Chisel and other tool marks** *surround this sauropod dinosaur humerus (upper arm bone) and are clear signs of attempted theft and vandalism. Training of rangers and other park staff in paleontological resource protection since 1997 is coincidental with, and may be directly related to, an increase in the documented cases of illegal fossil hunting activity over this period.*

## Battling Vandalism

# Geologic resource protection training increases park vigilance

*by Vince Santucci*

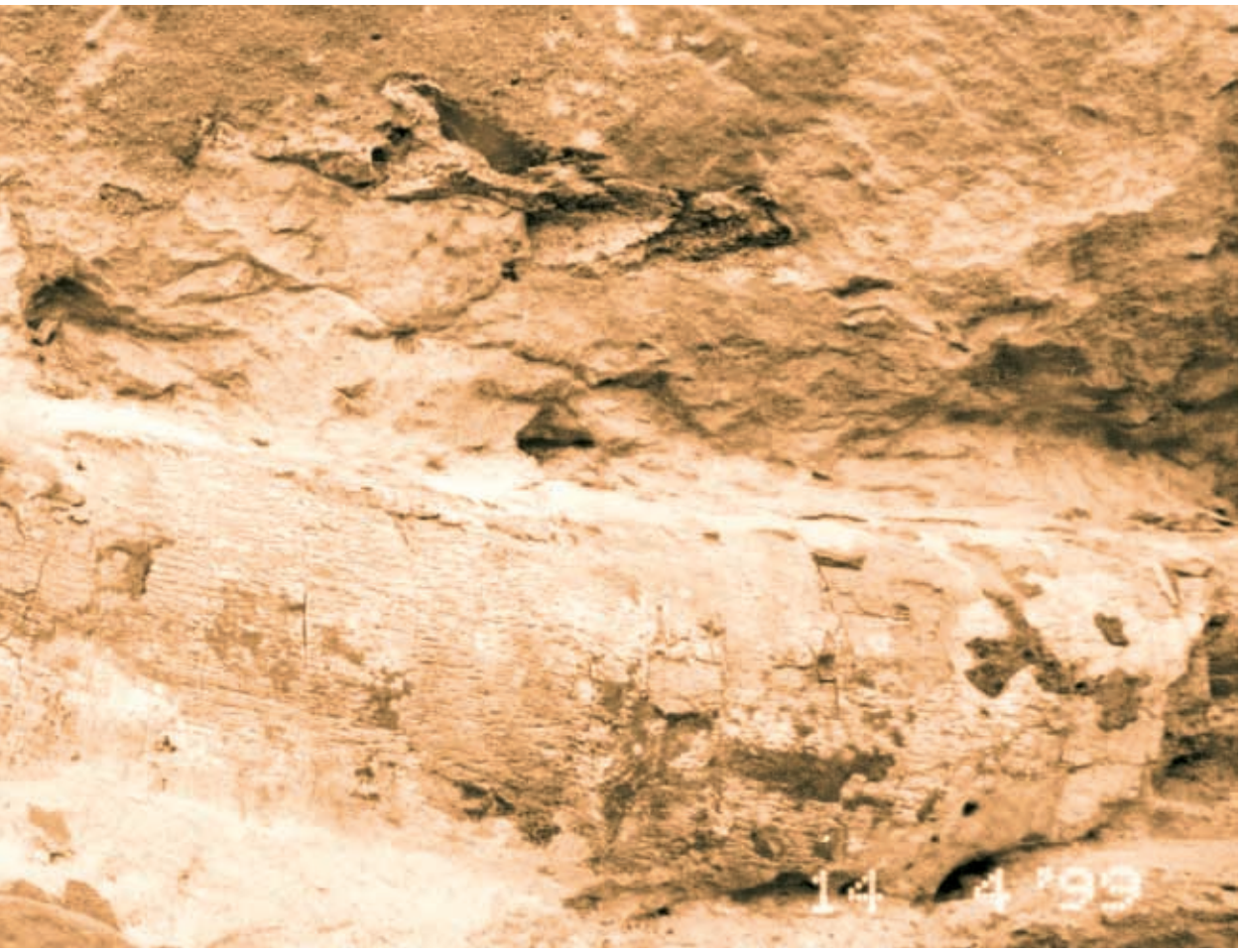
vincent_santucci@nps.gov
Paleontologist, Geologic Resources Division, and Chief Ranger, Fossil Butte National Monument, Wyoming

Park surveys conducted initially in 1992 and again in 1999 reveal some interesting trends in the recording of law enforcement incidents, citations, and arrests associated with the loss of paleontological resources from units of the national park system. During this time, the National Park Service increased its efforts to provide paleontological resource protection training to park staff. The data available from the two surveys show an apparent correlation between training and the increase in documented incidents of fossil theft or vandalism.

In 1999 the associate directors for natural resources and park operations jointly asked parks to participate in the survey, which also gathered information on the loss of cave and other geologic resources. However, because the 1992 survey included only paleontological resources, long-term data for caves and other geologic resources are not available.

> "The two surveys show an apparent correlation between training and the increase in documented incidents of fossil theft or vandalism."

Data from the 1992 survey were used to determine which geographic areas were most heavily impacted by fossil loss and where increased training may be valuable. These data showed that the highest incidence of paleontological resource loss was reported from parks in what is now the



Intermountain Region. Based upon the results of the 1992 survey, more than 250 NPS protection rangers, stationed in parks on the Colorado Plateau, Great Plains, and Mojave Desert, have participated in paleontological resource protection training over the past few years.

During the three years assessed in the initial survey (1989–1991), 16 parks reported incidents of paleontological resource loss, with a total of 154 issued citations totaling $5,920 in fines. During the three years assessed in the more recent survey (1995–1997), 16 parks reported incidents, with a total of 388 issued citations totaling $95,075 in fines. The survey data show a greater than 150% increase in the number of citations issued between the two periods assessed. The numbers of arrests reported in each of the surveys were not significantly different, with five reported during the initial survey and six in the more recent survey.

The data compiled in the surveys indicate a substantial increase in the number of documented cases of paleontological resource loss; however, whether this increase represents actual changes in visitor behavior or elevated awareness by park rangers leading to better documentation is unclear (see related story on fossil theft at Badlands National Park, page 41). The trend observed in national parks seems to parallel the escalation of the commercial market for fossils nationwide.

The continued monitoring of paleontological resource theft and vandalism in national parks, along with training of additional rangers (particularly in the Alaska Region), will enable a greater understanding of the variables influencing the loss of park fossils. The protection of these nonrenewable remains of past life is clearly part of the NPS mission.